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SOVIET STEAM JET COMPRESSORS AND THEIR USE IN INDUSTRY

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The use of steam jet compressors at steam-electric power plants and in the heat economy of industrial enterprises will frequently permit a reduction in live and high-pressure steam consumption by making possible the use of low-pressure steam from the bleed-off of central heating plant turbines. This will increase electric power productive capacity, on the basis of heat consumption, a factor of great significance, considering the limited capacity of boiler-operated steam-electric power plants.

Steam jet compressors also permit the utilization of the low-pressure exhaust steam from steam hammers, presses, etc., as a substitute for live steam. The use of jet compression of exhaust steam in drying apparatus, low-potential heating equipment and the like reduces live steam consumption 2 to 2½ times.

The compressor consists basically of a receiving chamber, jet, mixing chamber, and diffusor. The casing is steel pipe.

The basic index characterizing the effectiveness of the jet compressor is the coefficient of injection. The coefficient of injection u , is the ratio of the amount of low-pressure steam taken in by the compressor G_n to the input of working steam into the compressor G_r .

Proper installation of the nozzle, concentrically with the mixing chamber and at the correct distance from it, is very essential to the performance of the steam-jet compressor.

Up to the present, the optimum distance of the jet nozzle from the mixing chamber has been selected on the basis of experimental data.

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Using the fundamentals of the theory of free jet, the All-Union Heat-Engineering Institute developed a method for approximate calculation of the nozzle distance from the mixing chamber. The method is in satisfactory agreement with results of experimental investigation. The distance between the nozzle and mixing chamber is determined from conditions under which the free jet, at a given injection coefficient, would be exactly inscribed in the entrance cross section of the chamber.

At coefficients of injection $u > 0.2$, the length of free jet is calculated according to the formula: $S = \frac{0.37}{4.4a} u d_2$ where d_2 is diameter of the output section of the nozzle and a is an empirical constant with a value of 0.07-0.09.

The diameter d_k of free jet at the distance S from the nozzle is determined by the formula: $d_k = 1.6(1+u)d_2$.

Jet compressors give maximum effectiveness only under the operating conditions for which they were designed. Under variable conditions, when the parameters of live, injected or compressed flows deviate from those designed, the effectiveness of steam-jet compressors drops sharply, but may be considerably increased with the aid of artificial regulation.

The most frequent condition, occurring in the operation of jet compressors, is varying consumption of compressed steam in the line after the compressor.

Without regulation of the operation of compressors, a decrease in consumption of compressed steam leads to an increase in the compression pressure developed by the compressor and, as a result, the injection coefficient decreases, whereas consumption of live steam remains the same. When consumption of compressed steam becomes equal to consumption of live steam, the coefficient of injection will be zero.

Regulation of compressor performance at varying consumption of compressed steam may be realized by qualitative or quantitative methods. Qualitative regulation is effected by reducing the pressure of live steam before the compressor. The quantitative method of regulation is based on decreasing, with the aid of the "needles," the critical section area of the nozzle, maintaining unchanged live steam pressure in front of the compressor.

From the viewpoint of power preservation, quantitative regulation is more beneficial, because the efficiency of live steam is not reduced by this method. However, comparison of the characteristics of both methods shows that quantitative regulation does not significantly broaden the range of effective performance of a jet compressor and causes, at the same time, considerable complication of the construction due to installation of the regulating needle.

Qualitative regulation, accomplished by a valve in the live steam line, does not require any special regulating devices.

Steam-jet compressors are simple, inexpensive devices which may be manufactured directly in shops of electric power stations or industrial establishments.

In many cases expenses on installing a steam-jet compressor are absorbed in exceedingly short periods. With the utilization of jet compressors for compressing the exhaust steam of industrial establishments, the saving of fuel per million large calories of heat, used in the form of compressed steam with an industrial boiler installation efficiency equal to 0.6, amounts to 240 ~~140~~ kg of ideal fuel.

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At injection coefficients $u = 1.0-1.2$, which may be easily attained under conditions of industrial utilization of exhaust steam, the saving of fuel is equal to 120-130 kg of ideal fuel per million large calories.

Considerable economy may be attained by the utilization of steam-jet compressors in steam-electric power stations for replacing throttle live steam with steam from the bleed-off of the turbine.

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